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with its nutrient molecules which possess nitrogen, but which need some slight change in condition to give them vital activity. This change is effected by the further decomposition of the denitrogenized product of the previous oxidation. Acted on at once by the affinities of oxygen and of nutriment, it breaks up into two new molecules, one of which combines with oxygen, the other with the nutrient molecule. The energy set free by the oxidation suffices for the purposes of the nutrition process. As a final result we have protoplasm on the one hand, and degradation products, of no further use to the body, on the other. Like urea—the nitrogen waste—this carbon waste is now removed from the body, and the tissues are once more free and in condition for a repetition of the active vital process.

Such, or something not greatly unlike this, seems to be the organic process. Life appears to result from the play of the affinities of oxygen for nitrogen and carbon. Combination of oxygen with nitrogen compounds sets the wheels of life in motion, yielding energy which is free to produce organic motion. Combination with carbon compounds winds up again the clock of life, and prepares for a new period of activity. But the affinity of oxygen for the organic molecules is resisted, and cannot take place effectively except when assisted. Vibratory impulse, resulting from external irritation, aids its affinity for the nitrogen molecule, and induces the active state. Double chemical action aids its affinity for the carbon molecule, which it can attack only by aiding in the reformation of protoplasm. Possibly it may have slight powers of attack when unassisted, but its vigorous action seems to require these aids. And in this fact we have a possible solution of the mystery of life, for it is to some such play of affinities that sensory and motor activities, and the production of new protoplasm, are due, and in this sense organic life is a result of oxygen affinities.

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## INDIAN MUSIC.

BY EDWIN A. BARBER.

THE Indian tribes of America possess to-day but a limited knowledge of the art of music, though the Chippewas are said to have employed, to a limited extent, some years ago, a method of notation which was, at least, familiar to the medicine men of the tribe. A manuscript, which the traveler Catlin pro-

cured from the Indians themselves, is composed of pictorial devices painted on birch-bark, and was produced on certain occasions to suggest to the mind of the performer the particular song which it represented. It is stated that some of "The North American Indians also use rude little pictures, rough writing we may call it, to help them to remember songs and charms. Each verse of a song is concentrated into a little picture, the sight of which recalls the words to one who has once learned it. \* \* \* A picture of a circle, with a figure in the middle represents a verse of a love song, and says to the initiated, 'Were she on a distant island I could make her swim over.'"<sup>1</sup>

The musical instruments of the savage tribes of North America, however, were, and still are, of the most primitive sort, consisting of rattles made of wood, gourds, tortoise shells and the hoofs of deer, of bone whistles and of square or cylindrical skin-covered drums. Some of the savages of South America made flutes of the bones of wild animals, some of wood carved in the semblance of human heads, drums covered with the skin of monkeys and nondescript instruments made of variously-colored sea shells. One of the latter, which was exhibited at the last meeting of the Congress of *Americanistes* in Madrid, in the summer of 1881, was made of two parallel rods held together by eighteen shells, one end being ornamented with the jaw-bone of a man or monkey. The Indians inhabiting the interior of British Guiana still use rattles to accompany the music of the dance. In the Academy of Natural Sciences at Philadelphia are a number of interesting things from that country, in the valuable collection of the late Professor S. S. Haldeman. Several rattles are made of matting with black and white decoration. A conjuror's rattle consists of a large gourd with feather embellishments, and a painted and ornamented drum is covered at one end with the skin of a jaguar, the drum sticks resembling long lead pencils with large balls attached at one end.

It is necessary to look elsewhere for a higher development of the musical instinct in the Western continent. The ancient graves of the California coast have yielded a number of primitive flageolets of bone, possessing, in some instances, four or five finger-holes, which, doubtless, were capable of producing a variety of notes.

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<sup>1</sup>The Dawn of History. Edited by C. F. Keary, M.A., of the British Museum, London, 1878, p. 186.

In the cemeteries of Chiriqui, on the Isthmus of Panama, a large number of these unpretentious instruments have also been found, many of which have been elaborately molded from clay into representations of birds and animals.

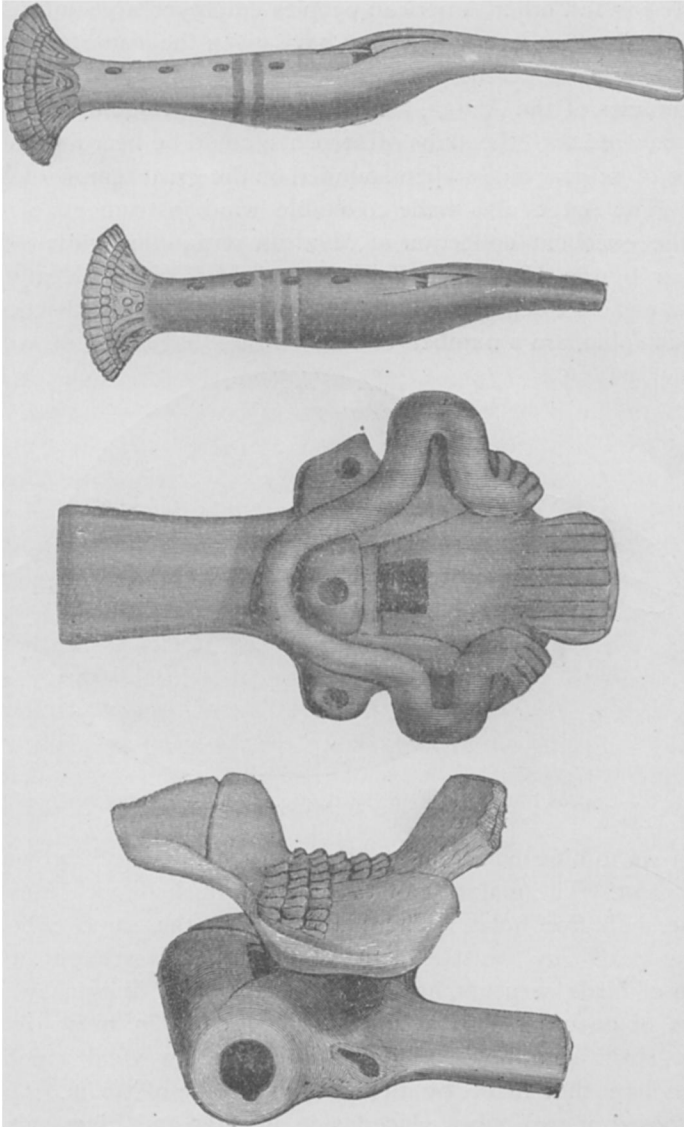


FIG. 1.—Mexican Wind Instruments: (clarionets and whistles) from the originals in the Poinsett & Keating Collection, Academy of Natural Sciences.

The ancient Mexicans used flutes, trumpets of sea shells and

other wind instruments. Several of these, now deposited in public museums, can be made to produce a series of notes in which the *fourth* and *seventh* are omitted, and certain authors have, therefore, reached the somewhat hasty conclusion that the Aztecs, Peruvians and other American peoples employed a peculiar scale of only five tones, to which they have given the name *pentatonic*. Instruments of percussion figured prominently in the religious ceremonies of the Aztecs, and the *huehuettl*, or huge drum, which was covered with the skins of serpents, could be heard for a distance of several miles when sounded on the great temple of Mexico. The Aztecs also made creditable wind instruments of clay. In the excellent collection of Mexican antiquities gathered together by the Hon. J. R. Poinsett and Mr. W. H. Keating in 1830, and now deposited in the Academy of Natural Sciences at Philadelphia, are a number of earthenware flageolets measuring

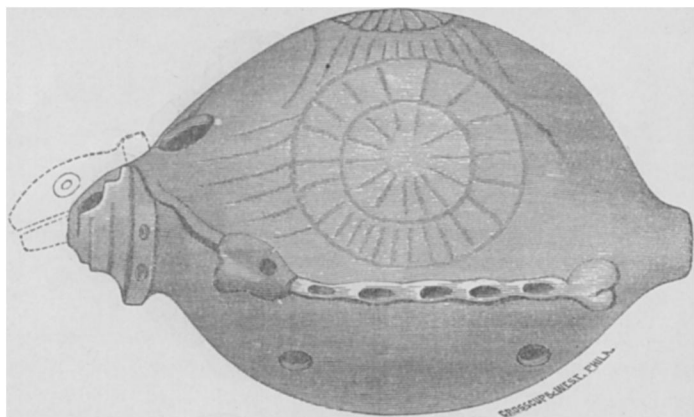


FIG. 2.—Curious Instrument from Ometkepec. From a drawing furnished by Dr. D. G. Brinton.

from six to nine inches in length and ornamented with brown and red paint. The majority of these are furnished with four, and some with five holes. There are also in the same collection many small clay whistles, some of them being wrought in the form of birds, serpents, heads of monsters and imaginary creatures of unsurpassable ugliness. They emit, in most cases, a clear, shrill sound when blown, though a few yield a peculiar noise like that made by the sudden escape of steam. One is composed of two tubes placed side by side, and gives out two distinct sounds.

Dr. Daniel G. Brinton has kindly furnished for this article the

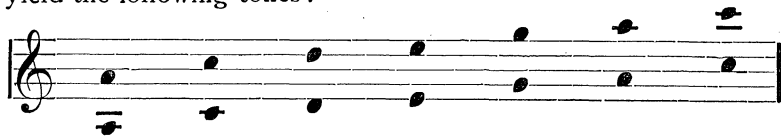
drawing and description of a curious antique musical instrument, somewhat resembling a turtle in form, which was procured from the Island of Ometepéc in the great lake of Nicaragua, by the late Dr. Berendt, during his recent excavations in Central America. It was found in connection with a shoe-shaped burial urn, with a quantity of roasted maize, is made of black clay, polished and ornamented with incised lines on the upper side, and possesses four holes arranged in a square on the lower. It was in all probability used by suspending it from the neck of the ancient musician by means of the two rings which project from either side near one end. When held in both hands, the lower part upward, the four holes being covered with the fingers, a variety of sounds can be produced by blowing into the neck or mouth. By a certain manipulation, a number of simple airs may be played, such, for instance, as the first part of "Yankee Doodle," and the following melody :



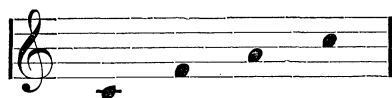
This unique relic is the first of the kind found amongst the remains of the old Nahuatl races which evinces any particular advancement in the art of music.

The Peruvians seem to have reached the greatest musical proficiency of any of the American races, and were also somewhat skilled in the mimetic arts. They were possessed of considerable histrionic ability, and combining their national songs with the drama, for the edification of their Incas, they produced rude operas, for which the principal actors were regularly educated. They made trumpets of baked clay resembling our modern bugle in form and which, possibly, were capable of being played in the same manner. They also had an instrument called the *huayra-puhura*, somewhat like the *syrinx* of the ancients, or Pandean pipes, which consisted of a number of hollow reeds or canes of varying lengths, fastened side by side, handled in the same manner as a mouth organ. One of these graceful instruments is preserved in

the British Museum, and consists of a double row of pipes which yield the following tones :



in which, it will be observed, the fourth and seventh are wanting; but another example in the extensive Peruvian collection of H. G. Clay, Esq., of Philadelphia, is made of four delicate reeds attached to a necklace of wampum, which emit the notes :



including the fourth, but omitting the seventh. Dr. Tschudi, in his great work on Peru, figures a syrinx composed of eight pipes, with a highly ornamented base and extra stops in the side.

Some of the modern Indians of Peru (the *Qquichua* and *Aymara* use a musical instrument somewhat resembling a flageolet (*qquena*), with which they make most melancholy music. Their *yaravis*, or tunes, are generally in the minor key, and when heard at a distance, or in the rarified atmosphere of the mountains in the night, are exceedingly impressive. Another instrument (the *chirimia*), a sort of clarionet, produces an even more melancholy music than the *qquena* and is generally played in concert of many instruments, while the latter is played in pairs. "The melodies played by these Indians," writes Señ. Don Frederico Blume, "are very peculiar and sentimental. It seems the performers are weeping over past glories. I was running the preliminary line for the Arequipa R. R., in 1861, and stopped over night at Quishuarani, a place (or rather the name of no place except a few huts scattered here and there among fig trees) some leagues below the village called Uchumayo, on the Arequipa or Chiri river. All at once I started in the midst of my sleep, roused by a terrific singing. After a considerable yelling which ended in a melancholy sigh, there followed a long *yaravi*, of course in the minor key, and then came another long, loud exclamation and then a most distressing *yaravi* again, and so on during the entire night. The news had just arrived by horse from Arequipa that the brother of the wife of Lecaros (in whose hut we were staying) was dead.

The announcement came, it seems, unexpectedly, and the explosion was that of a volcano of grief—terrible jets from time to time, then a quiet interval, and then again a great outburst, and so on. I have heard in Germany and elsewhere many masterpieces of music, but nothing to be compared with this dramatic and spontaneous opera. The exclamations were exclamations of grief, of pain, and the more quiet intervals were recitals of the whole life of the departed, by the sister, narrating how they had grown up together as children, how they had played and sometimes quarreled, and so on through later periods to the moment of receiving the news. His virtues and other qualities were reviewed and then grief overcame the woman and she cried out again, singing most distressfully:

“Thus I came to understand how their ‘operas’ originated and how natural a mode of expression they are.”

Mr. Blume also states that the musical compositions of Peru may be classed under three heads: *yaravis*, *catchuas* and *catchar-paris*, the two latter being used for dancing. “I saw at Totorá,” he writes me, “a grand procession at the funeral of a dead child. They had it adorned and tied to a shingle like a crucifix, but not with arms outstretched; and an Indian, holding the child high above his head in a vertical position, led the procession, which danced to the music of a weird song, from one village to another.”

This ceremony and the accompanying music were said to be very ancient. In the north of Peru the Indians have an instrument made of a flute and a bladder—a primitive bag-pipe—and another, a sort of xylophone, made of a series of pieces of hard, sonorous wood.

The historian Garcilasso quaintly writes of the ancient Peruvians: “In Musick they arrived to a certain harmony, in which the Indians of *Colla* did more particularly excell, having been the Inventors of a certain Pipe made of Canes glued together, every one of which having a different Note of higher and lower, in the manner of Organs, made a pleasing Musick by the dissonancy of sounds, the Treble, Tenor and Basse, exactly corresponding and answering each to other; with these Pipes they often plaid in consort, and made tolerable Musick, though they wanted the Quavers, Semiquavers, Aires, and many voices which perfect the Harmony amongst us. They had also other Pipes,



which were Flutes with four or five stops, like the Pipes of Shepherds; with these they played not in consort, but singly, and tuned them to Sonnets, which they composed in meetre, the subject of which was love, and the Passions which arise from the Favours or Displeasures of a Mistress. These Musicians were *Indians* trained up in that art for divertisement of the *Incas*, and the *Curacas*, who were his Nobles, which, as rustical and barbarous as it was, it was not common, but acquired with great Industry and Study.

“Every Song was set to its proper Tune; for two Songs of different subjects could not correspond with the same Aire, by reason that the Musick which the Gallant made on his Flute, was designed to express the satisfaction or discontent of his Mind, which were not so intelligible perhaps by the words as by the melancholy or chearfulness of the Tune which he plaid.”

The Bureau of Ethnology at Washington is now making preparations for the collection of data relating to the music and musical instruments of the various peoples of the new world, and many facts of an interesting nature will doubtless shortly be given to the scientific world in the hitherto comparatively untrodden field of native American music.

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## ON THE OCCURRENCE OF FOSSILIFEROUS STRATA IN THE LOWER PONENT (CATSKILL) GROUP OF MIDDLE PENNSYLVANIA.<sup>1</sup>

BY E. W. CLAYPOLE.

THE Catskill group of New York has been hitherto a great palæontological desert in American geology. Though much time and labor have been spent upon it by different geologists, little, I may almost say nothing, has thus far rewarded their labor. Here and there a few traces of life have been discovered, but these traces, faint and few as they were, have in many instances ended in disappointment, and now forty years after the establishment of the group by Professor Hall, the Catskill remains, even more than it was then, a great desert. The abundant life-remains that continue in New York to the very top of the Chemung there cease altogether. The abounding wealth of the Lower Carboniferous, especially in the West, sets in as soon

<sup>1</sup> Abstract of a paper read before the American Association for the Advancement of Science at Montreal, in August, 1882.